REMARKS

The present application was filed on August 2, 2001 with claims 1 through 44. Claims 1 through 44 are presently pending in the above-identified patent application. Claim 23 is proposed to be amended herein.

In the Office Action, the Examiner rejected claims 23-44 under 35 U.S.C. §101 because the claims pertain to a mathematical function without a practical application. The Examiner rejected claims 1-11, 16-24, 26-28, 33, and 39-44 under 35 U.S.C. §102(b) as being anticipated by Moshier (United States Patent Number 4,489,435). The Examiner indicated that claims 12-15, 25, 29-32, and 34-38 would be allowable if rewritten in independent form including all of the limitations of the base claims and any intervening claims.

Printed Publication

Applicants note that there is a typographical error in the printed publication of the present patent application. In particular, paragraph 71 should read:

> By the earlier argument, each function in L is completely separable. Define a collection of d sets $L_0, \ldots, L_{d-1}$ as follows: L_i is the collection of all ith components of all functions appearing in L. Thus, $L_i = \{f_{j,i}\}_{j=1}^{M}$. Now a key empirical observation may be made. This key observation is that, in general, for large collections of Gaussian mixtures like M, the number of distinct $\langle \mu_{j,i}, \sigma_{j,i} \rangle$ value pairs appearing in the functions of L is relatively small, even when the total number of distinct Gaussians in M is large. Moreover, even if the exact values of the multitude of $\langle \mu_{j,i}, \sigma_{j,i} \rangle$ values are distinct, to a good approximation they can be represented by a relatively small number of values. For instance, it has been empirically observed that for an acoustic model M containing tens of thousands or even hundreds of thousands of Gaussians, it suffices to have no more than 64 representatives per dimension.

Paragraph 71 of the printed publication reads:

> By the earlier argument, each function in L is completely separable. Define a collection of d sets $L_0, \ldots, L_{d-1}$ as follows: L_i is the collection of all ith components of all functions appearing in L. Thus, $L_i = \{f_{j,i}\}_{j=1}^{M}$. Now a key empirical observation may be made. This key observation is that, in general, for large collections of Gaussian mixtures like M, the number of distinct $\langle \mu_{j,i}, \sigma_{j,i} \rangle$ value pairs appearing in the

> functions of L is relatively small, even when the total number of distinct Gaussians in M is large. Moreover, even if the exact values of the multitude of $\langle \mu_{j,i}, v_{j,i} \rangle$ values are distinct, to a good approximation they can be represented by a relatively small number of values. For instance, it has been empirically observed that for an acoustic model M containing tens of thousands or even hundreds of thousands of Gaussians, it suffices to have no more than 64 representatives per dimension.

Section 101 Rejections

Claims 23-44 were rejected under 35 U.S.C. §101 because the claims pertain to a mathematical function without a practical application.

Claim 23 has been amended to require wherein said atom function is used to label speech. Applicants believe that the cited amendment addresses the Examiner's concerns and respectfully request that the section 101 rejections be withdrawn.

Independent Claims 1, 22 and 23

Independent claims 1, 22, and 23 were rejected under 35 U.S.C. §102(b) as being anticipated by Moshier. Regarding claims 1 and 22, the Examiner asserts that Moshier discloses "wherein ... kernel functions" as pattern score memory (Fig. 10, subblock 328) using word duration and phoneme duration as "atom" values when performing pattern comparison (col. 17, lines 42-60), while using a Gaussian (or Laplacian) to calculate s' (col. 17, lines 4-36); "adder circuitry ... indirect memory" as adding result to the accumulator (col. 17, lines 58-66).

Applicants note that the present invention is directed to the efficient storage and evaluation of the large acoustic models required by current speaker-independent, continuous speech recognition systems. Moshier does not address this problem. Applicants note that the indirect memory, atom functions and atom value memory cited in the claims of the present invention are all dedicated to the evaluation of observation likelihoods. The word duration, phoneme duration, pattern score memory and score register cited by the examiner are used in the *speech recognition search process*, and ***not*** in the *likelihood computation.*

Applicants also note that the cited components disclosed by Moshier have an entirely different function than defined in the present invention. The present invention provides hardware acceleration for the evaluation of the likelihoods of quantized acoustic

models for each observation vector in an utterance as part of a larger speech recognition system. The pattern score memory in Moshier (Fig. 10, subblock 328) supports *dynamic-programming search.* In addition, the atom values in the present invention are partial likelihood scores for a given observation vector, and are not comparable to the word duration and phoneme duration constraints disclosed in Moshier.

Regarding the "adder circuitry ... indirect memory," Applicants note that although Moshier and the present invention use adders and accumulators, the algorithms implemented are not the same. Moshier, for example, does ***not*** disclose or suggest the use of model approximation through *dimension-wise quantization*, and it therefore has ***no*** component comparable to the *indirect memory* of the present invention.

Independent claims 1 and 22 requires an ***indirect memory*** adapted to store a fixed plurality of indexes corresponding to a fixed plurality of atom functions; an atom value memory coupled to the indirect memory, the atom value memory adapted to store a fixed plurality of atom values corresponding to a fixed plurality of atom functions, wherein each of the indexes selects one of the atom values in the atom value memory, wherein each of the atom values is determined for a particular input vector and a particular atom function, and wherein the atom functions are selected to represent a plurality of kernel functions thereby providing an approximation to the plurality of kernel functions; and adder circuitry coupled to the atom value memory, the adder circuitry adapted to add atom values selected by indexes of the indirect memory. Independent claim 23, as amended, requires determining, for a particular input vector, a plurality of atom values, wherein each of the atom values is determined from an atom function that represents a plurality of kernel functions thereby providing an approximation to the plurality of kernel functions, and wherein said atom functions are used to label speech; loading a portion of the plurality of atom values into an atom value memory adapted to store a fixed number of atom values; loading a portion of a plurality of indexes into an ***indirect memory*** adapted to store a fixed number of indexes, each of the loaded indexes adapted to select one of the atom values in the atom value memory, each of the loaded indexes corresponding to one of a fixed number of kernel functions; selecting at least one index from the indirect memory; retrieving at least one atom value corresponding to the

at least one selected index from the atom value memory, one atom value retrieved per selected index; and accumulating the at least one retrieved atom value.

Thus, Moshier does not disclose or suggest an indirect memory adapted to store a fixed plurality of indexes corresponding to a fixed plurality of atom functions; an atom value memory coupled to the indirect memory, the atom value memory adapted to store a fixed plurality of atom values corresponding to a fixed plurality of atom functions, wherein each of the indexes selects one of the atom values in the atom value memory, wherein each of the atom values is determined for a particular input vector and a particular atom function, and wherein the atom functions are selected to represent a plurality of kernel functions thereby providing an approximation to the plurality of kernel functions; and adder circuitry coupled to the atom value memory, the adder circuitry adapted to add atom values selected by indexes of the indirect memory, as required by independent claims 1 and 22, and does not disclose or suggest determining, for a particular input vector, a plurality of atom values, wherein each of the atom values is determined from an atom function that represents a plurality of kernel functions thereby providing an approximation to the plurality of kernel functions, and wherein said atom functions are used to label speech; loading a portion of the plurality of atom values into an atom value memory adapted to store a fixed number of atom values; loading a portion of a plurality of indexes into an indirect memory adapted to store a fixed number of indexes, each of the loaded indexes adapted to select one of the atom values in the atom value memory, each of the loaded indexes corresponding to one of a fixed number of kernel functions; selecting at least one index from the indirect memory; retrieving at least one atom value corresponding to the at least one selected index from the atom value memory, one atom value retrieved per selected index; and accumulating the at least one retrieved atom value, as required by independent claim 23, as amended.

Dependent Claims 2-21 and 24-44

Dependent claims 2-11, 16-21, 24, 26-28, 33, and 39-44 were rejected under 35 U.S.C. §102(b) as being anticipated by Moshier.

Claims 2-21 and 24-44 are dependent on claims 1 and 23, respectively, and are therefore patentably distinguished over Moshier because of their dependency from amended independent claims 1 and 23 for the reasons set forth above, as well as

other elements these claims add in combination to their base claim. The Examiner has already indicated that claims 12-15, 25, 29-32, and 34-38 would be allowable if rewritten in independent form including all of the limitations of the base claims and any intervening claims.

All of the pending claims, i.e., claims 1-44, are in condition for allowance and such favorable action is earnestly solicited.

If any outstanding issues remain, or if the Examiner has any further suggestions for expediting allowance of this application, the Examiner is invited to contact the undersigned at the telephone number indicated below.

The Examiner's attention to this matter is appreciated.

Respectfully submitted,

Date: July 18, 2005

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